

**Corrections for: Senior, A.M and Nakagawa, S. 2013.
A comparative analysis of chemically induced sex reversal in teleosts: challenging conventional suppositions. *Fish and Fisheries*, 14(1), 60-76**

Having revisited this research for inclusion in my PhD thesis (A M Senior), I have realised two in-corrections in the published version.

- 1. In two places in the introduction and once in the discussion we refer to sex-determination controlled by somatic chromosomes. We mean sex-chromosomes, NOT somatic chromosomes.**
- 2. The supporting material published online, which contains our data bibliography, is incorrect (missing two references and two incorrect reference titles). A correct bibliography can be found below.**

As well as containing the aforementioned corrections, the version of this research in my PhD contains other edits (e.g. corrected typos/grammar and edits to improve fluency). If anyone would prefer a copy of the thesis version of this research, please feel free to email (alistair.senior1985@gmail.com).

References

- Abad, Z., Gonzalez, R., Mendoza, I., Oliva, A., Pinientel, E., Pimentel, R., Martinez, R., Estrada, M. P., Ramirez, Y., and Arenal, A. (2007). Production of a high percentage of male offspring in growth-enhanced transgenic tilapia using *Oreochromis aureus* ZZ selected pseudofemales. *Aquaculture*, 270, 541–545.
- Abucay, J. S. and Mair, G. C. (1997). Hormonal sex reversal of tilapias: implications of hormone treatment application in closed water systems. *Aquaculture Research*, 28, 841–845.
- Al-ablani, S. A. and Phelps, R. P. (1997). Sex reversal in black crappie *Pomoxis nigromaculatus*: effect of oral administration of 17 α -methyltestosterone on two age classes. *Aquaculture*, 158, 155–165.
- Andersen, D., Boetius, I., Larsen, L. O., and Seidler, P. H. (1996). Effects of oestradiol-enriched diet and of feeding with porcine testicular tissue on macroscopic gonadal sex in European eels. *Journal of Fish Biology*, 48, 484–492.
- Arslan, T. and Phelps, R. P. (2004a). Directing gonadal differentiation in bluegill, *Lepomis macrochirus* (Rafinesque), and black crappie, *Pomoxis nigromaculatus* (Lesueur), by periodic estradiol-17 beta immersions. *Aquaculture Research*, 35, 397–402.
- Arslan, T. and Phelps, R. P. (2004b). Production of monosex male black crappie, *Pomoxis nigromaculatus*, populations by multiple androgen immersion. *Aquaculture*, 234, 561–573.

- Atar, H. H., Bekcan, S., and Dogankaya, L. (2009). Effects of different hormones on sex reversal of rainbow trout (*Oncorhynchus mykiss* Walbaum) and production of all-female populations. *Biotechnology & Biotechnological Equipment*, *23*, 1509–1514.
- Balasubramani, A. and Pandian, T. J. (2008). Norethindrone ensures masculinization, normal growth and secondary sexual characteristics in the fighting fish, *Betta splendens*. *Current Science*, *95*, 1446–1453.
- Bang, I. C., Kim, Y., Kim, K. K., and Lee, J. K. (1995). Studies on the production of all-female populations of Olive Flounder, *Paralichthys olivaceus*. *Bulletin of the National Fisheries Research Development Agency*, *49*, 49–57.
- Bart, A. N., Athauda, A., Fitzpatrick, M. S., and Contreras-Sanchez, W. M. (2003). Ultrasound enhanced immersion protocols for masculinization of Nile tilapia, *Oreochromis niloticus*. *Journal of the World Aquaculture Society*, *34*, 210–216.
- Basavaraja, N., Gangadhad, B., and Udupa, K. (1997). Effect of diethylstilbestrol-incorporated diet on sex ratio and body composition of common carp, *Cyprinus carpio*. *Journal of Aquaculture in the Tropics*, *12*, 209–218.
- Basavaraja, N., Nandeesh, M. C., Varghese, T. J., Keshavanath, P., and Srikanth, G. K. (1990). Induction of sex reversal in *Oreochromis mossambicus* by diethylstilbestrol. *Journal of Applied Ichthyology*, *6*, 46–50.
- Bhandari, R. K., Nakamura, M., Kobayashi, T., and Nagahama, Y. (2006). Suppression of steroidogenic enzyme expression during androgen-induced sex reversal in Nile tilapia (*Oreochromis niloticus*). *General and Comparative Endocrinology*, *145*, 20–24.
- Blazquez, M., Felip, A., Zanuy, S., Carrillo, M., and Piferrer, F. (2001). Critical period of androgen-inducible sex differentiation in a teleost fish, the European sea bass. *Journal of Fish Biology*, *58*, 342–358.
- Blazquez, M., Piferrer, F., Zanuy, S., Carrillo, M., and Donaldson, E. M. (1995). Development of sex control techniques for European sea bass (*Dicentrarchus labrax* L)

- aquaculture: Effects of dietary 17 alpha-methyltestosterone prior to sex differentiation. *Aquaculture*, 135, 329–342.
- Blazquez, M., Zanuy, S., Carrillo, M., and Piferrer, F. (1998). Structural and functional effects of early exposure to estradiol-17 and 17-ethynylestradiol on the gonads of the gonochoristic teleost *Dicentrarchus labrax*. *Fish Physiology and Biochemistry*, 18, 37–47.
- Cek, S., Turan, F., and Atik, E. (2007a). The effects of Gokshura, *Tribulus terrestris* on sex reversal of Guppy, *Poecilia reticulata*. *Pakistan Journal of Biological Science*, 10, 718–725.
- Cek, S., Turan, F., and Atik, E. (2007b). Masculinization of Convict Cichlid (*Cichlasoma nigrofasciatum*) by immersion in *Tribulus terrestris* extract. *Aquaculture International*, 15, 109–119.
- Chiasson, M. and Benfey, T. J. (2007). Gonadal differentiation and hormonal sex reversal in arctic charr (*Salvelinus alpinus*). *Journal of Experimental Zoology Part a-Ecological Genetics and Physiology*, 307A, 527–534.
- Chiba, H., Iwatsuki, K., Hayamis, K., and Yamauchi, K. (1993). Effects of dietary estradiol-17b on feminization, growth and body composition in the Japanese eel (*Anguilla japonica*). *Comparative Biochemistry and Physiology*, 106a, 367–371.
- Colombo, G. and Grandi, G. (1995). Sex differentiation in the European Eel: histological analysis of the effects of sex steroids on the gonad. *Journal of Fish Biology*, 47, 394–413.
- Das, P., Mukhopadhyay, M., Das, K., and Pandit, P. (1986). Gonadal Sex Manipulation of *Oreochromis mossambicus* (Peters). In *Symposium on Selection, Hybridization and Genetic Engineering in Aquaculture of Fish and Shellfish for Consumption and Stocking.*, Bordeaux (France).
- Das, S. K., Shetty, H. P. C., and Nandeesh, M. C. (1990). Production of female-free common carp, *Cyprinus carpio* var. *communis* (L.) through dietary administration of the androgen mibolerone. *Asian Fisheries Science*, 3, 197–203.

- Davis, K. B., Goudie, C. A., Simco, B. A., Tiersch, T. R., and Carmichael, G. J. (1992). Influence of dihydrotestosterone on sex determination in channel catfish and blue catfish - period of developmental sensitivity. *General and Comparative Endocrinology*, 86, 147–151.
- Davis, K. B. and Ludwig, G. M. (2004). Hormonal effects on sex differentiation and growth in sunshine bass *Morone chrysops x Morone saxatilis*. *Aquaculture*, 231, 587–596.
- Degani, G. and Kushnirov, D. (1992). Effects of 17 β -estradiol and grouping on sex determination of European Eels. *The Progressive Fish-Culturist*, 54, 88–91.
- Demaska-Zakes, K., Luczynski, M. J., Darbowski, K., Luczynski, M., and Krol, J. (2000). Masculinization of northern pike fry using the steroid 11 beta-hydroxyandrostenedione. *North American Journal of Aquaculture*, 62, 294–299.
- Demaska-Zakes, K. and Zakes, Z. (1997). Effect of 17 α -methyltestosterone on gonadal differentiation in pikeperch, *Stizostedion lucioperca* L. *Aquaculture Research*, 28, 59–63.
- Deng, G. Y., Chen, L.-Q., Wang, X.-M., Oshiro, T., and Takashima, F. (2001). Sex reversal and gonadal development of triploid Rainbow trout (*Oncorhynchus mykiss*). *Acta Zoologica Sinica*, 47, 71–78.
- Desprez, D., Geraz, E., Hoareau, M. C., Melard, C., Bosc, P., and Baroiller, J. F. (2003). Production of a high percentage of male offspring with a natural androgen, 11h-hydroxyandrostenedione (11hOHA4), in Florida red tilapia. *Aquaculture*, 216, 55–65.
- Drummond, C. D., Murgas, L. D. S., and Vicentini, B. (2009). Growth and survival of tilapia *Oreochromis niloticus* (Linnaeus, 1758) submitted to different temperatures during the process of sex reversal. *Ciencia E Agrotecnologia*, 33, 895–902.
- Flynn, S. R. and Benfey, T. J. (2007). Effects of dietary estradiol-17 beta in juvenile shortnose sturgeon, *Acipenser brevirostrum*, Lesueur. *Aquaculture*, 270, 405–412.

- Fujioka, Y. (2002). Effects of hormone treatments and temperature on sex-reversal of Nigrobona *Carassius carassius grandoculis*. *Fisheries Science*, 68, 889–893.
- Galbreath, P. F., Adams, N. D., and Sherrill, L. W. (2003). Successful sex reversal of brook trout with 17 alpha-methyldihydrotestosterone treatments. *North American Journal of Aquaculture*, 65, 235–239.
- Galvez, J. I., Mazik, P. M., Phelps, R. P., and Mulvaney, D. R. (1995). Masculinization of Channel Catfish *Ictalurus punctatus* by Oral Administration of Trenbolone Acetate. *Journal of the World Aquaculture Society*, 26, 378–383.
- Galvez, J. I., Morrison, J. R., and Phelps, R. P. (1996). Efficacy of Trenbolone Acetate in Sex Inversion of the Blue Tilapia *Oreochromis aureus*. *Journal of the World Aquaculture Society*, 27, 483–486.
- Garrett, G. P. (1989). Hormonal sex control of Largemouth Bass. *The Progressive Fish-Culturist*, 51, 146–148.
- George, T. and Pandian, T. J. (1995). Production of ZZ females in the female-heterogametic black molly, *Poecilia sphenops*, by endocrine sex reversal and progeny testing. *Aquaculture*, 136, 81–90.
- George, T. and Pandian, T. J. (1996). Hormonal induction of sex reversal and progeny testing in the zebra cichlid *Cichlasoma nigrofasciatum*. *Journal of Experimental Zoology*, 275, 374–382.
- Gomelsky, B., Cherfas, N. B., Peretz, Y., Ben-Dom, N., and Hulata, G. (1994). Hormonal sex inversion in the common carp (*Cyprinus carpio* L.). *Aquaculture*, 126, 265–270.
- Goryczko, K., Bieniarz, K., Dobosz, S., and Grudniewska, J. (1991). The effects of 17B-estradiol on rainbow trout (*Oncorhynchus mykiss* walb.). *Polish Archives of Hydrobiology*, 38, 303–309.

- Goudie, C. A., Redner, B. D., Simco, B. A., and Davis, K. B. (1983). Feminization of channel catfish by oral administration of steroid sex hormones. *Transactions of the American Fisheries Society*, 112, 670–672.
- Grillitsch, B., Altmann, D., Schabuss, M., Zornig, H., Sommerfeld-Stur, I., and Mostl, E. (2010). Mammalian glucocorticoid metabolites act as androgenic endocrine disruptors in the Medaka (*Oryzias latipes*). *Environmental Toxicology and Chemistry*, 29, 1613–1620.
- Guerrero III, R. D. (1975). Use of androgens for the production of all-male *Tilapia aurea* (Steindachner). *Transactions of the American Fisheries Society*, 104, 342.
- Guerrero III, R. D. and Guerrero, L. A. (1993). Effects of oral treatment of mibolerone on sex reversal of *Oreochromis mossambicus*. *Asian Fisheries Science*, 6, 347–350.
- Guiguen, Y., Baroiller, J. F., Ricordel, M. J., Iseki, K., McMeel, O. M., Martin, S. A. M., and Fostier, A. (1999). Involvement of Estrogens in the Process of Sex Differentiation in Two Fish Species: The Rainbow Trout (*Oncorhynchus mykiss*) and a Tilapia (*Oreochromis niloticus*). *Molecular Reproduction and Development*, 54, 154–162.
- Guzel, S., Yoruk, M., Gullu, K., and Karaca, T. (2008). Effects of Oral Administration of Estradiol Valerate on Gonadal Sex Differentiation in the Rainbow Trout, *Oncorhynchus mykiss*. *Journal of Animal and Veterinary Advances*, 7, 1400–1404.
- Hackmann, E. and Reinboth, R. (1974). Delimitation of the Critical Stage of Hormone-Influenced Sex Differentiation in *Hemihaplochromis multicolor* (Hilgendorf) (Cichlidae). *General and Comparative Endocrinology*, 22, 42–53.
- Haniffa, M. A., Sridhar, S., and Nagarajan, M. (2004). Hormonal manipulation of sex in stinging catfish *Heteropneustes fossilis* (Bloch). *Current Science*, 86, 1012–1017.
- Herman, R. L. and Kincaid, H. L. (1991). Effects of orally administered steroids on Lake Trout and Atlantic Salmon. *The Progressive Fish-Culturist*, 53, 157–161.

- Hulak, M., Paroulek, M., Simek, P., Kocour, M., Gela, D., Rodina, M., and Linhart, O. (2008). Water polluted by 17 α -methyltestosterone provides successful male sex inversion of common carp (*Cyprinus carpio* L.) from gynogenetic offspring. *Journal of Applied Ichthyology*, *24*, 707–710.
- Hulak, M., Psenicka, M., Gela, D., Rodina, M., and Linhart, O. (2010). Morphological sex change upon treatment by endocrine modulators in meiogynogenetic tench (*Tinca tinca* L.). *Aquaculture Research*, *41*, 233–239.
- Hurk, R. V. D. and Slof, G. A. (1981). A Morphological and Experimental Study of Gonadal Sex Differentiation in the Rainbow Trout, *Salmo gairdneri*. *Cell and Tissue Research*, *218*, 487–497.
- Jessy, D. and Varghese, T. J. (1988). Hormonal Sex Control in *Betta splendens* Regan and *Xiphophorus helleri* Heckel. In *Proceedings of the First Indian Fisheries Forum.*, Mangalore (India). Asian Fisheries Society, Indian Branch.
- Johnstone, R., Simpson, T. H., and Walker, A. F. (1979). Sex reversal in salmonid culture part III. The production and performance of all-female populations of Brook Trout. *Aquaculture*, *18*, 241–252.
- Johnstone, R., Simpson, T. H., and Youngson, A. F. (1978). Sex reversal in salmonid culture. *Aquaculture*, *13*, 115–134.
- Kamaruzzaman, N., Nguyen, N. H., Hamzah, A., and Ponzoni, R. W. (2009). Growth performance of mixed sex, hormonally sex reversed and progeny of YY male tilapia of the GIFT strain, *Oreochromis niloticus*. *Aquaculture Research*, *40*, 720–728.
- Karayucel, I., Penman, D., Karayucel, S., and McAndrew, B. (2003). Thermal and hormonal feminization of all male YY Nile tilapia, *Oreochromis niloticus* L. *Israeli Journal of Aquaculture-Bamidgeh*, *55*, 114–122.
- Kavumpurath, S. and Pandian, T. J. (1992). Production of the YY male in the Guppy, *Poecilia reticulata* by endocrine sex reversal and progeny testing. *Asian Fisheries Science*, *5*, 265–276.

- Kavumpurath, S. and Pandian, T. J. (1993). Determination of labile period and critical dose for sex reversal by oral administration of estrogens in *Betta splendens* (Regan). *Indian Journal of Experimental Biology*, 31, 16–20.
- Kavumpurath, S. and Pandian, T. J. (1994). Masculinization of fighting fish, *Betta splendens* Regan, using synthetic or natural androgens. *Aquaculture and Fisheries Management*, 25, 373–381.
- Kim, D. S., Nam, Y. K., and Jo, J. Y. (1997). Effect of oestradiol-17 beta immersion treatments on sex reversal of mud loach, *Misgurnus mizolepis* (Gunther). *Aquaculture Research*, 28, 941–946.
- Kirankumar, S., Anathy, V., and Pandian, T. J. (2003). Hormonal induction of supermale golden rosy barb and isolation of Y-chromosome specific markers. *General and Comparative Endocrinology*, 134, 62–71.
- Kirankumar, S. and Pandian, T. J. (2002). Effect on growth and reproduction of hormone immersed and masculinized fighting fish *Betta splendens*. *Journal of Experimental Zoology*, 293, 606–616.
- Kitano, T., Takamune, K., Nagaham, Y., and Abe, S. (2000). Aromatase inhibitor and 17 alpha-methyltestosterone cause sex-reversal from genetical females to phenotypic males and suppression of P450 aromatase gene expression in Japanese flounder (*Paralichthys olivaceus*). *Molecular Reproduction and Development*, 56, 1–5.
- Kitano, T., Yoshinaga, N., Shiraishi, E., Koyanagi, T., and Abe, S. (2007). Tamoxifen induces masculinization of genetic females and regulates P450 aromatase and Mullerian inhibiting substance mRNA expression in Japanese flounder (*Paralichthys olivaceus*). *Molecular Reproduction and Development*, 74, 1171–1177.
- Kobayashi, H. and Iwamatsu, T. (2005). Sex reversal in the *Medaka Oryzias latipes* by brief exposure of early embryos in estradiol-17beta. *Zoological Science*, 22, 1163–1167.
- Komatsu, T., Nakamura, S., and Nakamura, M. (2006). Masculinization of female golden rabbitfish *Siganus guttatus* using an aromatase inhibitor treatment during

- sex differentiation. *Comparative Biochemistry and Physiology C-Toxicology & Pharmacology*, 143, 402–409.
- Kubota, Z., Nakajima, I., and Watanabe, N. (1988). Influence of oral treatment of estrone on the sex reversal of the loach *Misgurnus anguillicaudatus*. *The Journal of Shimonoseki University of Fisheries*, 35, 61–68.
- Kuwaye, T. T., Okimoto, D. K., Shimoda, S. K., Howerton, R. D., Lin, H. R., Pang, P. K. T., and Grau, E. G. (1993). Effect of 17 α -methyltestosterone on the growth of the euryhaline tilapia, *Oreochromis mossambicus*, in fresh water and in sea water. *Aquaculture*, 113, 137–152.
- Kwon, J. Y., Haghpanah, V., Kogson-Hurtado, L. M., McAndrew, B. J., and Penman, D. J. (2000). Masculinization of Genetic Female Nile Tilapia (*Oreochromis niloticus*) by Dietary Administration of an Aromatase Inhibitor During Sexual Differentiation. *Journal of Experimental Zoology*, 287, 46–53.
- Lee, P., King, H., and Pankhurst, N. (2004). Preliminary assessment of sex inversion of farmed atlantic Salmon by dietary and immersion androgen treatments. *North American Journal of Aquaculture*, 66, 1–7.
- Lee, S., Na, O. S., Yeo, I. K., Baek, H. J., and Lee, Y. D. (2000). Effects of sex steroid hormones and high temperature of sex differentiation in black rockfish, *Sebastes schlegelii*. *Journal of the Korean Fisheries Society*, 33, 373–377.
- Lim, B. H., Phang, V. P. E., and Reddy, P. K. (1992). The effects of short-term treatment of 17 α -methyltestosterone and 17 β -estradiol on growth and sex ratio in the red variety of swordtail, *Xiphophorus helleri*. *Journal of Aquaculture in the Tropics*, 7, 267–274.
- Luczynski, M. J., Demska-Zakes, K., Dabrowski, K., and Luczynski, M. (2003). Masculinization of gynogenetic northern pike juveniles using 17 α -methyltestosterone. *North American Journal of Aquaculture*, 65, 255–259.
- Macintosh, D. J., Varghese, T. J., and Rao Satyanarayana, G. P. (1985). Hormonal sex reversal of wild-spawned tilapia in India. *Journal of Fish Biology*, 26, 87–94.

- Mair, G. C., Penman, D. J., Scott, A., Skibinski, D. O. F., and Beardmore, J. A. (1987). Hormonal Sex-Reversal and the Mechanisms of Sex Determination in *Oreochromis*. *Proceedings of The World Symposium on Selection, Hybridization and Genetic Engineering in Aquaculture, Bordeaux, 2*, 27–30.
- Malison, J. A., Kayes, T. B., Best, C. D., Amundson, C. H., and Wentworth, B. C. (1986). Sexual-differentiation and the use of hormones to control sex in Yellow Perch (*Perca-flavescens*). *Canadian Journal of Fisheries and Aquatic Sciences*, *43*, 26–35.
- Manzoor Ali, P. K. M. and Rao, G. P. S. (1989). Growth Improvement in Carp, *Cyprinus carpio* (Linnaeus), Sterilized with 17 α -Methyltestosterone. *Aquaculture*, *76*, 157–167.
- Marjani, M., Jamili, S., and Mostafavi, P. G. (2009). Influence of 17-Alpha Methyl Testosterone on Masculinization and Growth in Tilapia (*Oreochromis mossambicus*). *Journal of Fisheries and Aquatic Science*, *4*, 71–74.
- Martin-Robichaud, D. J., Peterson, R. H., Benfey, T. J., and Crim, L. M. (1994). Direct feminization of lumpfish (*Cyclopterus lumpus* L.) using 17 β -oestradiol-enriched Artemia as food. *Aquaculture*, *123*, 137–151.
- Melard, C. (1995). Production of a high percentage of male offspring with 17 α -ethynylestradiol sex-reversed *Oreochromis auresus* .1. estrogen sex-reversal and production of F2 psuedofemales. *Aquaculture*, *130*, 25–34.
- Meriwether, F. H. and Torrans, E. L. (1986). Evaluation of a new androgen (mibolerone) and procedure to induce functional sex reversal in tilapia. In *The First Asian Fisheries Forum*, Manila (Philippines).
- Murata, R., Karimata, H., Alam, M. A., and Nakamura, M. (2010). Precocious sex change and spermatogenesis in the underyearling Malabar grouper *Epinephelus malabaricus* by androgen treatment. *Aquaculture Research*, *41*, 303–308.
- Nagaraj, C. G. and Rao, G. P. S. (1988). Effect of testosterone acetate and estradiol benzoate on sexuality and growth of *Cyprinus carpio* (Linn). In *Proc. First Indian Fish. Forum*, Mangalore, 115–117. Asian Fish. Soc., Indian Branch.

- Nagy, A., Bercsenyi, M., and Csanyi, V. (1981). Sex reversal in carp (*Cyprinus carpio*) by oral administration of methyltestosterone. *Canadian Journal of Fisheries and Aquatic Sciences*, 38, 725–728.
- Nakamura, M. (1975). Dosage dependent changes in the effect of oral administration of methyltestosterone on gonadal sex differentiation in *Tilapia mossambica*. *Bulletin of the Faculty of Fisheries Hokkaido University*, 26, 99–108.
- Nakamura, M. (1981). Effects of 11-ketotestosterone on gonadal sex differentiation in *Tilapia mossambica*. *Bulletin of the Japanese Society of Scientific Fisheries*, 47, 1323–1327.
- Nakamura, M. and Iwahashi, M. (1982). Studies on the practical masculinization of *Tilapia nilotica* by the oral administration of androgen. *Bulletin of the Japanese Society of Scientific Fisheries*, 48, 763–769.
- Nakamura, M. and Takahashi, H. (1973). Gonadal Sex Differentiation in *Tilapia mossambica*, with Special Regard to the Time of Estrogen Treatment Effective in Inducing Complete Feminization of Genetic Males. *Bulletin of the Faculty of Fisheries Hokkaido University*, 24, 1–13.
- Nandeesh, M. C., Srikanth, G. K., Basavaraja, N., Varghesh, T. J., Keshavanath, P., Shetty, H. P. C., and Das, S. K. (1990). Effect of mibolerone on sex-reversal in *Oreochromis mossambicus*. *Current Science*, 59, 748–750.
- Navarro-Martin, L., Blazquez, M., and Piferrer, F. (2009). Masculinization of the European sea bass (*Dicentrarchus labrax*) by treatment with an androgen or aromatase inhibitor involves different gene expression and has distinct lasting effects on maturation. *General and Comparative Endocrinology*, 160, 3–11.
- Okada, H. (1973). Studies on sex differentiation of salmonidae - Effects of estrone on sex differentiation off the rainbow trout (*Salmo gairdnerii irideus* Gibbons). *Scientific Reports of the Hokkaido Fish Hatchery*, 28, 11–21.

- Okada, H., Matumoto, H., and Yamazaki, F. (1979). Functional Masculinization of genetic females in Rainbow Trout. *Bulletin of the Japanese Society of Scientific Fisheries*, 45, 413–419.
- Omoto, N., Maebayashi, M., Mitsuhashi, E., Yoshitomi, K., Adachi, S., and Yamauchi, K. (2002). Effects of estradiol-17 beta and 17 alpha-methyltestosterone on gonadal sex differentiation in the F-2 hybrid sturgeon, the bester. *Fisheries Science*, 68, 1047–1054.
- Owusu-Frimpong, M. and Nijjhar, B. (1980). Induced sex reversal in *Tilapia nilotica* (Cichlidae) with methyl testosterone. *Hydrobiologia*, 78, 157–160.
- Park, I. S., Kim, H. B., Huh, H. T., and Kim, S. C. (1993). Masculinization of Masu Salmon (*Oncorhynchus masou*) by treatments of 17a-methyltestosterone. *Ocean Research*, 15, 29–36.
- Park, I. S., Kim, J. H., Cho, S. H., and Kim, D. S. (2004). Sex differentiation and hormonal sex reversal in the bagrid catfish *Pseudobagrus fulvidraco* (Richardson). *Aquaculture*, 232, 183–193.
- Phelps, R. P., Cole, W., and Katz, T. (1992). Effect of fluoxymesterone on sex ratio and growth of Nile tilapia, *Oreochromis niloticus* (L.). *Aquaculture and Fisheries Management*, 23, 405–410.
- Piferrer, F., Baker, I. J., and Donaldson, E. M. (1993). Effects of natural synthetic aromatizable and nonaromatizable androgens in inducing male sex differentiation in genotypic female chinook salmon (*Oncorhynchus tshawytscha*). *General and Comparative Endocrinology*, 91, 59–65.
- Piferrer, F., Carrillo, M., Zanuy, S., Solar, I. I., and Donaldson, E. M. (1994). Induction of sterility in coho salmon (*Oncorhynchus kisutch*) by androgen immersion before first feeding. *Aquaculture*, 119, 409–423.
- Piferrer, F. and Donaldson, E. M. (1991). Dosage-dependent differences in the effect of aromatizable and nonaromatizable androgens on the resulting phenotype of coho salmon (*Oncorhynchus kisutch*). *Fish Physiology and Biochemistry*, 9, 145–150.

- Pongthana, N., Penman, D. J., Baoprasertkul, P., Hussain, M. G., Islam, M. S., Powell, S. F., and McAndrew, B. J. (1999). Monosex female production in the silver barb (*Puntius gonionotus* Bleeker). *Aquaculture*, *173*, 247–256.
- Potts, A. C. and Phelps, R. P. (1995). Use of diethylstilbestrol and ethynylestradiol to feminize Nile tilapia *Oreochromis niloticus* (L.) in an outdoor environment. *Journal of Applied Ichthyology*, *11*, 111–117.
- Rao, H. N. S. and Rao, G. P. S. (1983). Hormonal manipulation of sex in the Common Carp, *Cyprinus carpio* var. *communis* (Linnaeus). *Aquaculture*, *35*, 83–88.
- Ridha, M. T. and Lone, K. P. (1990). Effect of oral administration of different levels of 17 α -methyltestosterone on the sex reversal, growth and food conversion efficiency of the tilapia *Oreochromis spilurus* (Günther) in brackish water. *Aquaculture and Fisheries Management*, *21*, 391–397.
- Ridha, M. T. and Lone, K. P. (1995). Preliminary studies on feminization and growth of *Oreochromis spilurus* (Günther) by oral administration of 17 α -ethynylestradiol in sea water. *Aquaculture Research*, *26*, 479–482.
- Rinhard, J., Dabrowski, K., Garcia-Abiado, M. A., and Ottobre, J. (1999). Uptake and depletion of plasma 17 α -methyltestosterone during induction of masculinization in muskellunge, *Esox masquinongy*: Effect on plasma steroids and sex reversal. *Steroids*, *64*, 518–525.
- Rougeot, C., Kanfitine, S. Y., Prignon, C., Gennotte, V., and Mélard, C. (2008). Early sex reversal during embryonic development in the Nile tilapia. *Cybium*, *32*, 104–105.
- Ruksana, S., Pandit, N. P., and Nakamura, M. (2010). Efficacy of exemestane, a new generation of aromatase inhibitor, on sex differentiation in a gonochoristic fish. *Comparative Biochemistry and Physiology C-Toxicology & Pharmacology*, *152*, 69–74.
- Santos, M. M., Micael, M., Carvalho, A. P., Morabito, R., Booy, P., Massanisso, P., Lamoree, M., and Reis-Henriques, M. A. (2006). Estrogens counteract the masculin-

- izing effect of tributyltin in zebrafish. *Comparative Biochemistry and Physiology C-Toxicology & Pharmacology*, 142, 151–155.
- Schmelzing, T. O. and Gall, G. A. E. (1991). Use of 17-methyltestosterone to sex inverse gynogenic female rainbow trout. *Journal of Applied Ichthyology*, 7, 120–128.
- Sehgal, G. and Saxena, P. (1995a). Effect of 17 α -methyltestosterone on sex composition, growth and flesh composition in common carp, *Cyprinus carpio* (L.) *communis*. *Indian Journal of Experimental Biology*, 33, 169–172.
- Sehgal, G. and Saxena, P. (1995b). Effect of 5- α -dihydrotestosterone on sex composition, growth and flesh composition in common carp, *Cyprinus carpio*. *Proc. Indian Natl. Sci. Acad, Part B* 61, 431–436.
- Sehgal, G. and Saxena, P. (1997a). Effect of estrone on sex composition, growth and flesh composition in common carp, *Cyprinus carpio communis* (Linn.). *Journal of Aquaculture in the Tropics*, 12, 289–295.
- Sehgal, G. and Saxena, P. (1997b). Effects of estradiol-17B on sex composition, growth and flesh composition in common carp, *Cyprinus carpio communis* (Linn.). *Indian Journal of Experimental Biology*, 34, 498–501.
- Shelton, W. L., Rodriguez-Guerrero, D., and Lopez-Macias, J. (1981). Factors affecting androgen sex reversal of *Tilapia aurea*. *Aquaculture*, 25, 59–65.
- Smith, E. S. and Phelps, R. P. (2001). Impact of feed storage conditions on growth and efficacy of sex reversal of Nile Tilapia. *North American Journal of Aquaculture*, 63, 242–245.
- Sobhnana, K. S. and Nandeesh, M. C. (1994). Standardization of mibolerone dosage for production of female-free common carp (*Cyprinus carpio* var. *communis* L.) and the impact of the hormone on growth and flesh composition. *Journal of Aquaculture in the Tropics*, 9, 133–139.
- Solar, I. I. and Donaldson, E. M. (1985). Studies on genetic and hormonal sex control in domesticated rainbow trout. II. Use of methyltestosterone for masculinisation

- and sterilisation in cultured rainbow trout (*Salmo gairdneri* Richardson). *Canadian Technical Report of Fisheries and Aquatic Sciences*, 1380, 1–9.
- Solar, I. I., Donaldson, E. M., and Hunter, G. A. (1984). Optimization of Treatment regimes for controlled sex differentiation and sterilization in wild Rainbow Trout (*Salmo gairdneri* Richardson) by oral administration of 17 α methyltestosterone. *Aquaculture*, 42, 129–139.
- Son, J. K. (1991). Histological studies of sex reversal. *Korean Journal of Animal Science*, 33, 339–341.
- Sower, S. A., Dickhoff, W. W., Flagg, T. A., and Mighell, J. L. (1984). Effects of estradiol and diethylstilbestrol on sex reversal and mortality in Atlantic Salmon (*Salmo salar*). *Aquaculture*, 43, 75–81.
- Sower, S. A., Schreck, C. B., and Evenson, M. (1983). Effects of steroids and steroid antagonists on growth, gonadal development, and RNA/DNA ratios in juvenile steelhead trout. *Aquaculture*, 32, 243–254.
- Sun, P., You, F., Liu, M. X., Wu, Z. H., Wen, A. Y., Li, J., Xu, Y. L., and Zhang, P. J. (2010). Steroid sex hormone dynamics during estradiol-17 beta induced gonadal differentiation in *Paralichthys olivaceus* (Teleostei). *Chinese Journal of Oceanology and Limnology*, 28, 254–259.
- Takahashi, H. (1975). Masculinization of the gonad of juvenile guppy, *Poecilia reticulata*, induced by 11-ketotestosterone. *Bulletin of the Faculty of Fisheries Hokkaido University*, 26, 11–22.
- Tanaka, H. (1988). Effects of estradiol-17B on gonadal sex differentiation in flounder, *Paralichthys olivaceus*. *Bulletin of the National Research Institute of Aquaculture*, 13, 17–23.
- Tayaman, M. M. and Shelton, W. L. (1978). Inducement of sex reversal in *Sarotherodon niloticus* (Linnaeus). *Aquaculture*, 14, 349–354.

- Torrans, L., Meriwether, F. H., Lowell, F., Wyatt, B., and Gwinup, P. D. (1988). Sex-reversal of *Oreochromis aures* by immersion in mibolerone, a synthetic steroid. *Journal of World Aquaculture*, 19, 97–102.
- Turan, F., Cek, S., and Atik, E. (2006). Production of monosex male guppy, *Poecilia reticulata*, by 17 alpha-methyltestosterone. *Aquaculture Research*, 37, 200–203.
- Uchida, D., Yamashita, M., Kitano, T., and Iguchi, T. (2004). An aromatase inhibitor or high water temperature induce oocyte apoptosis and depletion of P450 aromatase activity in the gonads of genetic female zebrafish during sex-reversal. *Comparative Biochemistry and Physiology a-Molecular & Integrative Physiology*, 137, 11–20.
- Varadaraj, K. (1990). Production of monosex male *Oreochromis mossambicus* (Peters) by administering 19-norethisterone acetate. *Aquaculture and Fisheries Management*, 21, 133–135.
- Varadaraj, K., Kumari, S. S., and Pandian, T. J. (1994). Comparison of conditions for hormonal sex reversal of Mozambique tilapias. *Progressive Fish-Culturist*, 56, 81–90.
- Vera-Cruz, E. M. and Mair, G. C. (1994). Conditions for effective androgen sex reversal in *Oreochromis niloticus* (L.). *Aquaculture*, 122, 237–248.
- Wang, H. P., Gao, Z. X., Beres, B., Ottobre, J., Wallat, G., Tiu, L., Rapp, D., O'Bryant, P., and Yao, H. (2008). Effects of estradiol-17 beta on survival, growth performance, sex reversal and gonadal structure of bluegill sunfish *Lepomis macrochirus*. *Aquaculture*, 285, 216–223.
- Wassermann, G. J. and Afonso, L. O. B. (2003). Sex reversal in Nile tilapia (*Oreochromis niloticus* Linnaeus) by androgen immersion. *Aquaculture Research*, 34, 65–71.
- Woiwode, J. G. (1977). Sex reversal of *Tilapia zilli* by ingestion of methyltestosterone. *Bureau of Fisheries and Aquaculture*, 1, 1.

Yamamoto, T.-O. and Kajishima, T. (1968). Sex Hormone Induction of Sex Reversal in the Goldfish and Evidence for Male Heterogamity '. *Journal of Experimental Zoology*, 168, 215–222.

Yamazaki, F. (1976). Application of Hormones in Fish Culture. *Journal of the Fish Research Board of Canada*, 33, 948–958.